BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images may include (but are not limited to):

- BLACK BORDERS
- TEXT CUT OFF AT TOP, BOTTOM OR SIDES
- FADED TEXT
- ILLEGIBLE TEXT
- SKEWED/SLANTED IMAGES
- COLORED PHOTOS
- BLACK OR VERY BLACK AND WHITE DARK PHOTOS
- GRAY SCALE DOCUMENTS

IMAGES ARE BEST AVAILABLE COPY.

As rescanning documents *will not* correct images, please do not report the images to the Image Problem Mailbox.

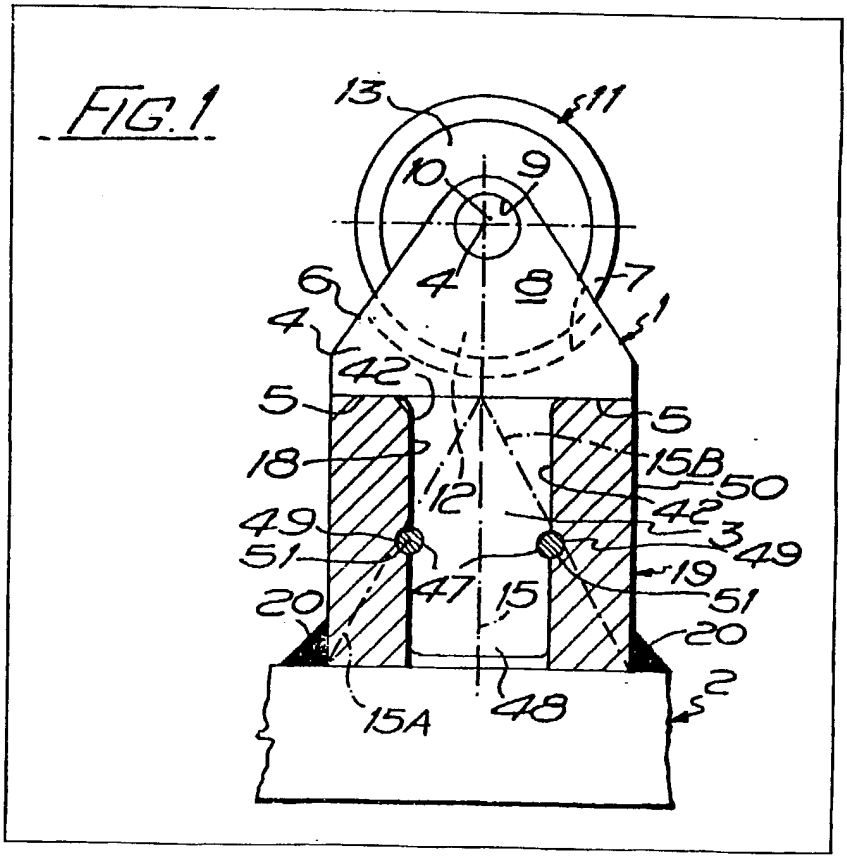
(12) UK Patent Application (19) GB (11) 2 035 417 A

(21) Application No 7939525
(22) Date of filing 15 Nov 1979
(30) Priority data
(31) 78/46070
(32) 25 Nov 1978
(33) United Kingdom (GB)
(43) Application published
18 Jun 1980
(51) INT CL³
E21C 35/18
(52) Domestic classification
E1F 17
(56) Documents cited
GB 1218308
GB 1188361
GB 677979
GB 606973
GB 478289
GB 476130
GB 294819
(58) Field of search
E1F
(71) Applicants
Hall & Pickles Limited,
Hydra Works,
Ecclesfield,
Sheffield S30 3ZF
(72) Inventors
Sydney Howe
(74) Agents
Hulse & Co.

(54) **Tools for cutting heads**

(57) A cutting tool 1 for mounting on a rotary cutting head 2 comprises a shank 3 for insertion in an aperture 18 of the rotary cutting head 2, an enlarged head 4 at one end of the shank 3 providing at least one seating surface 5 for the cutting tool 1, the shank 3 being provided with a formation or element 47, 49, 52, 58, by which it may be releasably retained within the aperture 18, a slot 7 provided in a side 6 of the tool head 4 remote from the shank 3, a spindle 10 secured across the slot 7 and a roller cutter 11 mounted on the spindle 10 and rotatable with respect to the tool head 4, a portion 12 of the roller cutter 11 being locatable in the slot 7 and another portion 13 of the roller cutter 11 projecting from the tool head 4 in a direction away from the shank 3.

FIG. 1



GB 2 035 417 A

2035417

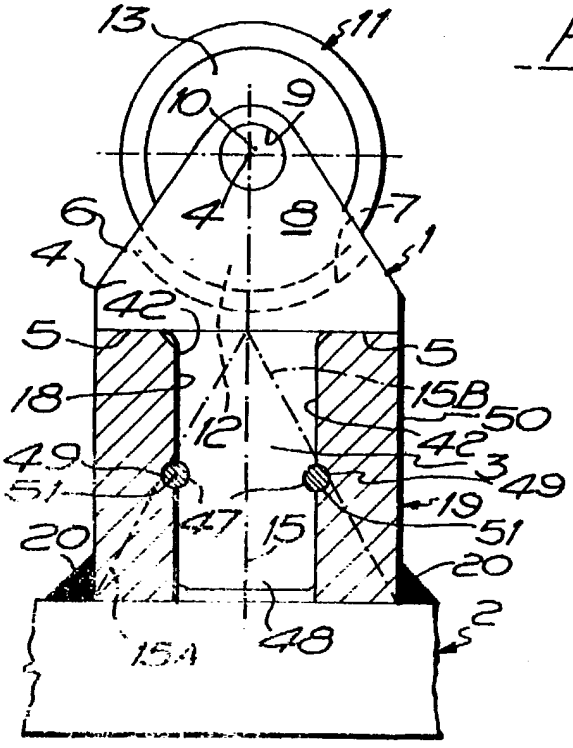


FIG 1

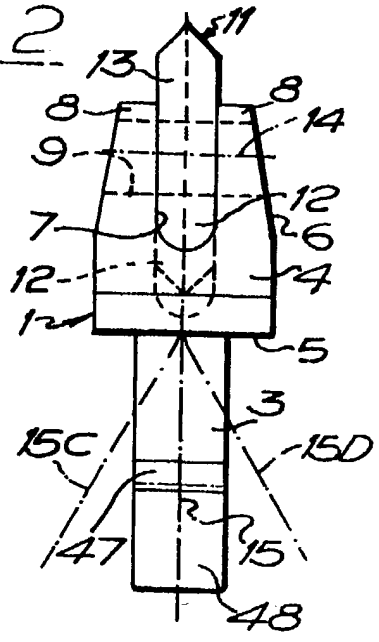


FIG. 2

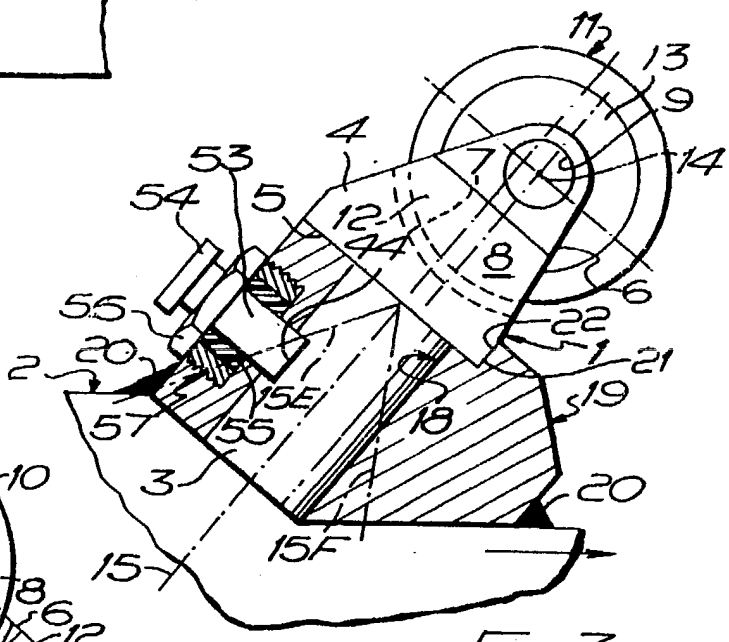


FIG. 3

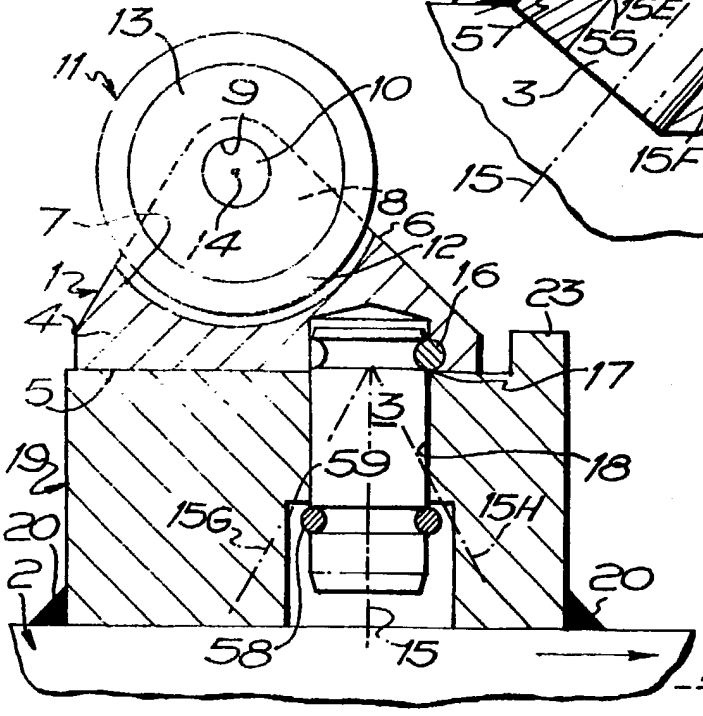


FIG. 4

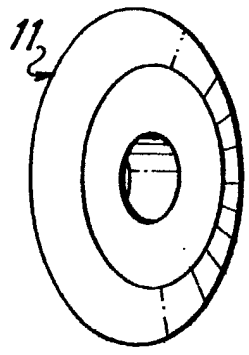


FIG. 5A

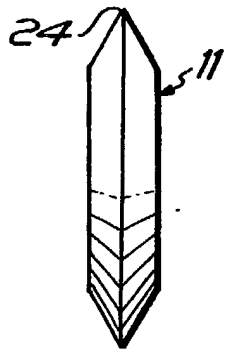


FIG 5B

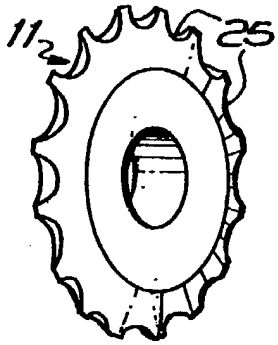


FIG. 6A

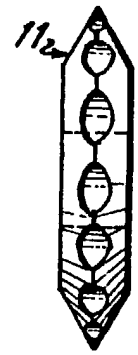


FIG. 6B

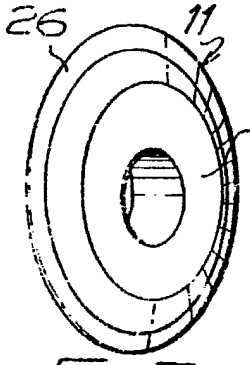


FIG. 7A

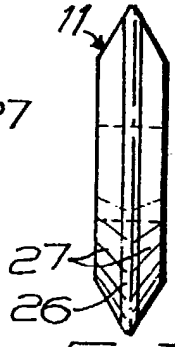


FIG. 7B

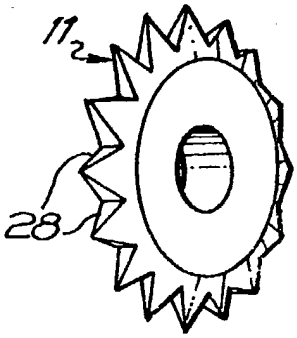


FIG. 8A

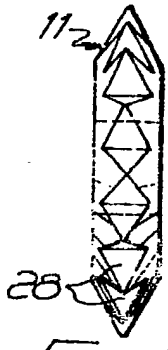


FIG 8B

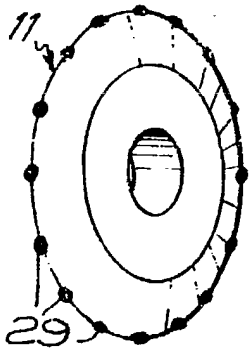


FIG. 9A

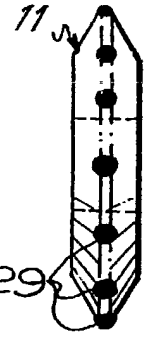


FIG. 9B

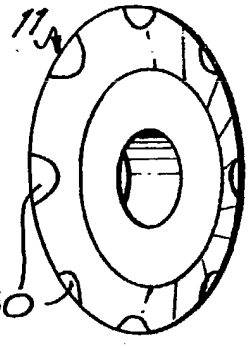


FIG 10A

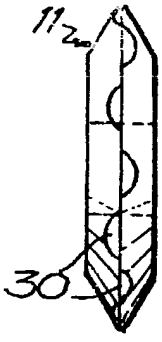


FIG 10B

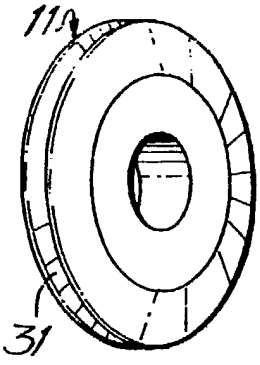


FIG. 11A

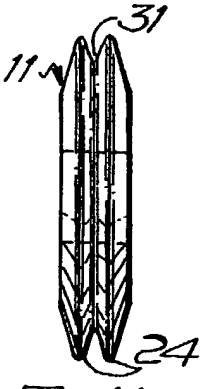


FIG 11B

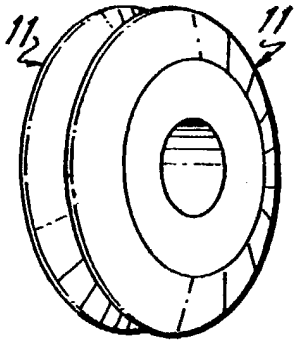


FIG 12A

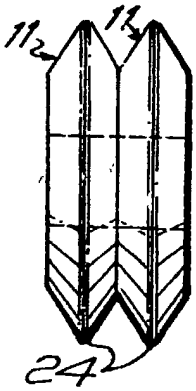


FIG. 12B

2035417

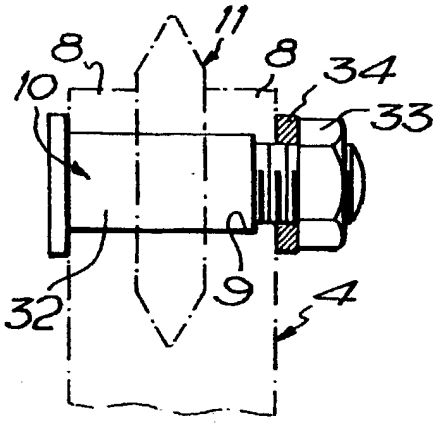


FIG. 13

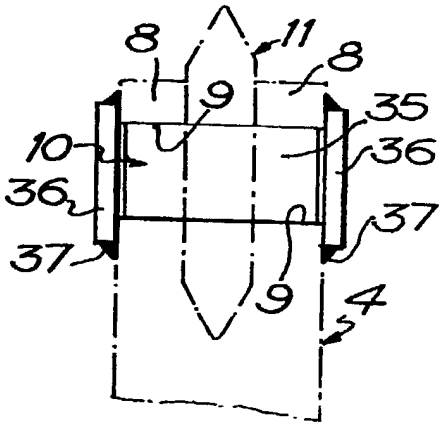


FIG. 14

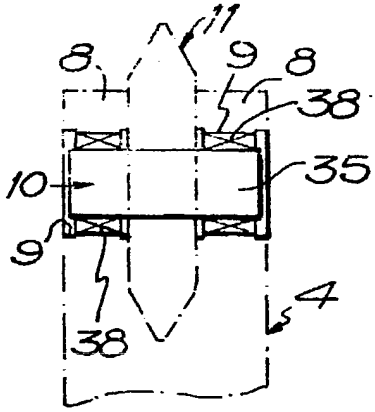


FIG. 15

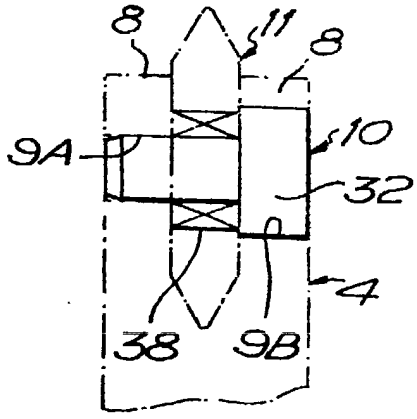


FIG. 16

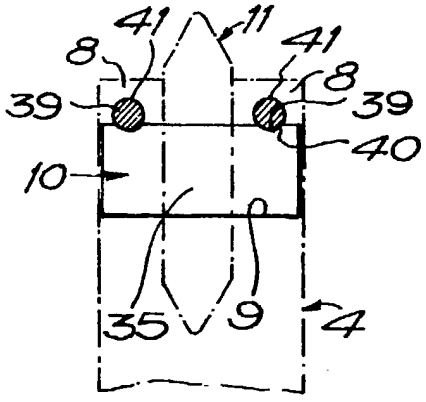


FIG. 17

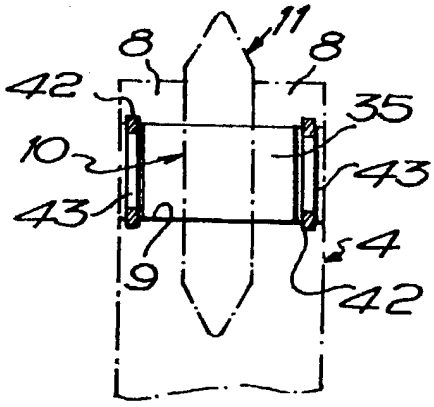


FIG. 18

2035417

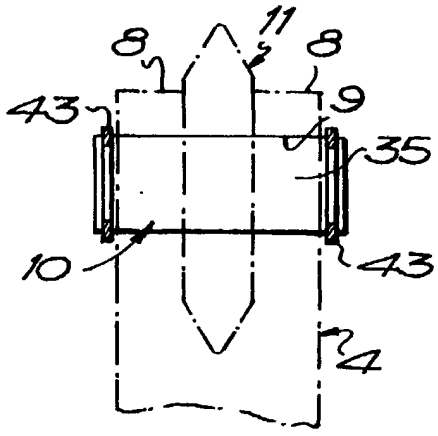


FIG. 19

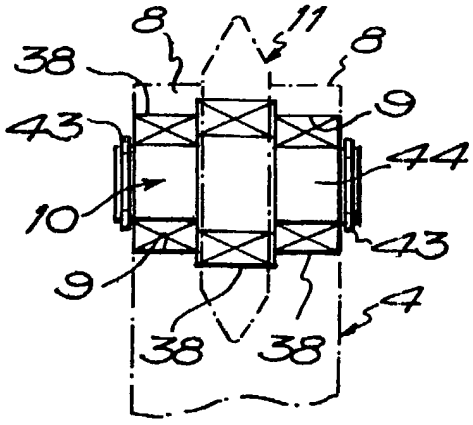


FIG. 20

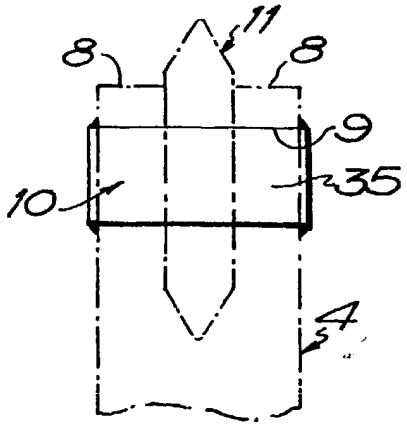


FIG. 21

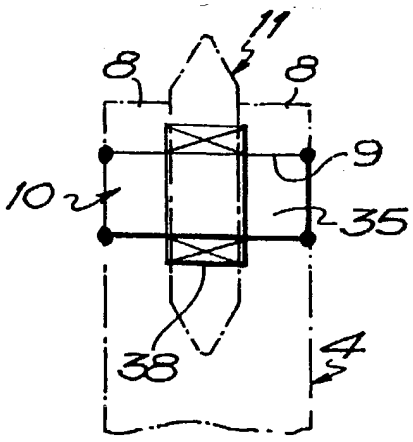


FIG. 22

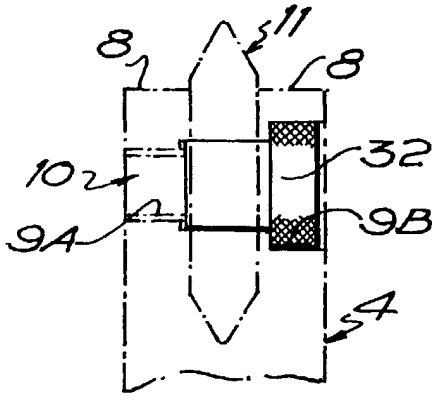


FIG. 23

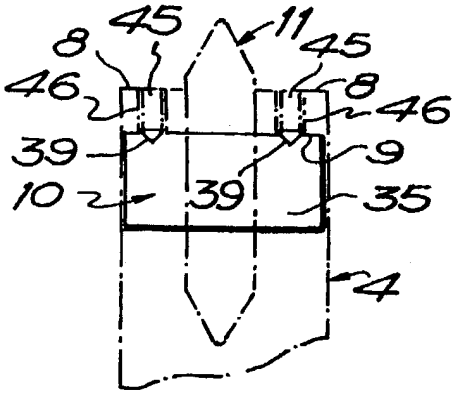


FIG. 24

SPECIFICATION

Tools for cutting heads

This invention relates to cutting tools for mounting on a rotary cutting head of a mineral cutting machine and to a rotary cutting head provided with such tools. Such tools are used for coal cutting, e.g. on long-wall machines of the shearer type; for rock cutting, e.g. on boom-type roadway driving machines; and for civil engineering uses both underground, e.g. tunnelling through rock, and above ground, e.g. planing road surfaces.

The object of the present invention is to provide improved and readily serviceable tools and rotary cutting heads capable of cutting very hard materials.

According to a first aspect of the present invention, a cutting tool for mounting on a rotary cutting head comprises a shank for insertion in an aperture of the rotary cutting head, an enlarged head at one end of the shank providing at least one seating surface for the cutting tool, the shank being provided with a formation or element by which it may be releasably retained within the aperture, a slot provided in a side of the tool head remote from the shank, a spindle secured across the slot and a roller cutter mounted on the spindle and rotatable with respect to the tool head, a portion of the roller cutter being located within the slot and another portion of the roller cutter projecting from the tool head in a direction away from the shank.

According to a second aspect of the present invention, a rotary cutting head for a mineral cutting machine is provided with a plurality of tools as defined above.

It will be appreciated that when a roller cutter is damaged and or worn, the whole tool can be removed from the rotary cutting head and a replacement tool fitted with the removed tool being refurbished, if possible, dependent upon the extent of damage and/or wear. Furthermore, down time of the cutting head is minimised by removing a worn and/or damaged tool(s) and replacing it with a fresh tool.

Basically, the cutting tool may be generally elongate or may be cranked. Rotation of the roller cutter with respect to the tool head may be effected by rotatably mounting the roller cutter on the spindle. Alternatively, the roller cutter may be fixed to the spindle with the latter rotatably mounted in the tool head. Yet again the roller cutter may be rotatably mounted on the spindle and the spindle rotatably mounted in the tool head. Rotation between the rotary cutter and spindle and or spindle and tool head may be accommodated by journal bearings, roller bearings or ball bearings provided between the components involved. The roller or ball bearings may be of the of the pre-sealed kind requiring no lubrication in service, or alternatively for any form of bearing a grease hole or nipple may be provided. It is also preferred for the spindle to be readily removable from the tool head.

The axis of rotation of the spindle may lie on the central longitudinal axis of the shank. Alternatively, the spindle axis may be in advance of, or behind, this shank axis. The spindle may be located at right angles or at <45° to the plane of the slot.

The shank may be of circular or non-circular cross-section.

The spindle may be secured to the tool head by welding; circlips; a threaded part of the spindle engaging a nut or a tapped hole in the tool head; grub screws; or two pins engaging grooves in the spindle, one to each side of the slot.

The roller cutter may be constituted by one or more disc-like cutters; may be formed with a plurality of cutting edges, which can be sharp, flat or round; may be formed of a material of greater hardness than the remainder of the roller cutter; may be provided with hard metal inserts, e.g. of tungsten carbide, or hard metal facings e.g. deposited by spraying or welding and may have indentations or reliefs to afford greater cutting efficiency; while a plurality of cutting edges, whether provided on one roller cutter or on a plurality of roller cutters may be all of one diameter and thickness or vary in diameter and or thickness.

Conveniently, the one or more seating surfaces of the tool head are flat surfaces. In principle, the tool head may be fixed with respect to the shank e.g. by being a one-piece forging, or may be rotatable with respect to the shank e.g. by separate elements forming the tool head and the shank, the elements being rotatably secured together.

Preferably, the rotary cutter(s) are produced by casting from a strong, wear-resistant metal, e.g. high chromium and/or manganese steel.

With regard to the rotary cutting head, the aperture to receive the shank may be of circular or non-circular cross-section to match that of the shank, and may be constituted by a through bore or a blind socket. Furthermore, the aperture therein is preferably provided in a mounting box for each cutting tool, the mounting boxes being secured by welding to the rotary cutting bead. The one or more seating surfaces of the tool head are preferably constituted by flat surfaces to seat on corresponding surfaces of the mounting box, the flat surfaces determining the extent of penetration of a tool shank into its aperture. The formation on, or elements of, the shank, serving to retain releasably the shank within its aperture may be constituted by any suitable arrangement, as will be described in detail later.

If the tool shank is of circular cross-section, the mounting box may be provided with a flat surface for locating against a corresponding flat shoulder of the tool, to prevent rotation of the latter within the mounting box.

The invention will now be described in greater detail, by way of example, with reference to the accompaning drawings, in which:-

Figure 1 is a side elevation, partly in section of a first embodiment of cutting tool and rotary cutting head in accordance with the present invention;

Figure 2 is an end elevation of the cutting tool of Figure 1;

Figure 3 corresponds to Figure 1 but shows a second embodiment of both cutting tool and mounting box;

Figure 4 corresponds to Figure 1 but shows a third

embodiment of both cutting tool and mounting box;

Figure 5A and *5B* are respectively a perspective view and an end elevation of the rotary cutter of Figures 1 and 2;

Figures 6A and *6B* to *12A* and *12B* correspond to Figures 5A and 5B but show seven alternative embodiments; and

Figures 13 to *24* show twelve embodiments of spindle arrangements.

In all the Figures, like reference numerals are accorded to like components.

A cutting tool 1 is shown in Figures 1, 3, and 4 mounted on a rotary cutting head 2, e.g. of a boom-type underground roadway driving machine.

The cutting tool 1 comprises a shank 3, of rectangular section in Figures 1 and 2, and of circular section in Figures 3 and 4. At one end of the shank 3 is an enlarged tool head 4, the head being integral with the shank in the embodiments of Figures 1 to 3, and rotatable with respect to the shank in the embodiment of Figure 4, as will be described in detail later. The tool head 4 on its underside, provides flat seating surfaces 5 while at a side 6 of the tool head 4, remote from the shank 3, there is provided a slot 7 defined between a pair of cheeks 8. In each cheek 8 is provided a coaxial aperture 9, these apertures receiving respectively opposite ends of a spindle 10 which is thereby secured across the slot 7. A roller cutter 11 is rotatably mounted on the spindle in the embodiments of Figures 1 to 4 at least, with a portion 12 of the roller cutter 11 located within the slot and another portion 13 of the roller cutter 11 projecting from the tool head 4 in a direction away from the shank 3. The roller cutter 11 has an axis of rotation 14 and furthermore it will be appreciated that during use, rotation of the roller cutter 11 results in the portions 12 and 13 changing position and presenting fresh cutting portions.

As can be seen from Figures 1 and 2, the cutting tool 1 may be generally elongate, the shank 3 having a central longitudinal axis 15, the axis of rotation 14 lying on the longitudinal axis 15 and hence with the embodiment of Figure 1, it is irrelevant whether the rotary cutting head 2 rotates clockwise or anti-clockwise. However, in the embodiments of Figures 3 and 4, the rotary cutting head 2 rotates clockwise so that the axis of rotation 14 in Figure 3 is ahead of the longitudinal axis 15 while in Figure 4 the axis of rotation 14 is behind the longitudinal axis 15, the choice between the posibilities exemplified in Figures 1, 3 and 4 being determined at last to some extent by particular operating conditions.

Also as indicated in Figures 1 to 4 is the possibility of cranking the shank 3 with respect to the tool head 4 with the shank 3 having a longitudinal axis shown at 15A, 15B, 15C, 15D, 15E, 15F, 15G, or 15H.

In the embodiments of Figures 1, 2, and 3, the tool head 4 is forged integrally with the shank 3. In the embodiment of Figure 4 however, the tool head 4 is rotatably secured to the shank 3 by a steel pin 16 carried by the tool head 4 and partially located within a peripheral groove 17 provided in the shank 3.

As can be seen from Figures 1, 3, and 4 the shank 3 is inserted in an aperture 18, of cross-section corresponding to that of the particular shank involved, provided in a mounting box 19 secured by welds 20 to the rotary cutting head 2. With the circular cross-section shank 3 of Figure 3, the tool head 4 is provided with a flat 21 which abuts a corresponding flat 22 provided on the mounting box 19, to prevent rotation of the shank 3 within the aperture 18. The embodiment of Figure 4 is also illustrated as having a shank 3 with a circular cross-section, although non-circular cross-sections are equally possible. Also in the Figure 4 embodiment, the mounting box 19 is provided with an abutment 23 to prevent complete rotation of the tool head 4. Thus, the trailing arrangement of Figure 4 allows the shank 3 to rotate, within limits, to achieve a self-centring effect, the cutting tool 1 finding its own location with respect to the mounting box 19 dependent upon the forces encountered in service.

In Figures 5A and 5B is shown the rotary cutter 11 of Figures 1 and 2, the rotary cutter 11 being a casting and having a single, annular cutting edge 24. In Figures 6A and 6B is shown a rotary cutter 11 provided with a plurality of peripheral arcuate indentations 25 defining a plurality of cutting edges. In Figures 7A and 7B, the rotary cutter 11 is provided with a one-piece or multi-piece annular insert 26 of tungsten carbide. The insert 26 can be located in an annular groove in the rotary cutter 11 or can be sandwiched between two side plates 27. In Figures 8A and 8B is shown a rotary cutter 11 having a plurality of 'V'-shaped peripheral notches 28 again providing a plurality of cutting edges. In Figures 9A and 9B a plurality of tungsten carbide buttons 29 are inserted in peripheral sockets. In Figures 10A and 10B the rotary cutter is provided on opposite sides with alternating recesses 30 again to provide a plurality of cutting edges. In Figures 11A and 11B, the rotary cutter 11 is provided with an annular peripheral groove 31 to define two annular cutting edges 24. In Figures 12A and 12B, two rotary cutters 11 of the kind shown in Figures 5A and 5B are ganged together and may be secured together e.g. by welding, to provide two annular cutting edges 24.

In Figure 13, the spindle 10 is constituted by a headed bolt 32 on which is journaled the rotary cutter 11, the bolt 32 being secured by a nut 33 with a washer 34. In Figure 14, the spindle 10 is constituted by a circular section pin 35, on which is journalled the roller cutter 11, the pin 35 being retained by closure plates 36 welded at 37 over the outside of each aperture. Furthermore, the pin 35 may be either journalled, or fixed, in the aperture 9. In the embodiment of Figure 15, the rotary cutter 11 is fixed to a spindle 10 constituted by a pin 35, the pin 35 being mounted in roller or ball bearings 38 located in each aperture 9. In Figure 16 the spindle 10 is constituted by a headed bolt 32 screwed into a tapped aperture 9A the bolt head being housed within an enlarged aperture 9B, while the bolt shank carries a roller or ball bearing 38 on which the rotary cutter 11 is mounted. In Figure 17 the spindle 10 is constituted by a pin 35, on which is journalled the rotary cutter 11, the pin 35 having two spaced apart tangential grooves 39 each to receive a portion of one retaining pin 40 inserted along parallel apertures 41 in the cheeks 8. The grooves 39 could of course be

circumferential. In Figure 18, the spindle 10 is constituted by a pin 35, on which is journalled the rotary cutter 11, while each aperture 9 has an annular recess 42 to receive a circlip 43. In Figure 19, the spindle 10 is constituted by a pin 35 having two spaced apart annular grooves to receive a circlip 43, the rotary cutter again being journalled on the pin 35. In Figure 20, the spindle 10 is constituted by a stepped pin 44 again having two spaced apart annular grooves to receive a circlip 43, the pin 44 being mounted in roller or ball bearings 38 located in each aperture 9, while the rotary cutter 11 is mounted on a third roller or ball bearing 38. In Figure 21 the spindle 10 is constituted by a pin 35 on which the rotary cutter 11 is journalled, the pin being welded at its ends to the cheeks 8. In Figure 22 the spindle 10 is constituted by a pin 35 welded at its ends to the cheeks 8 and carrying a roller or ball bearing 38 on which the rotary cutter 11 is mounted. In Figure 23, the spindle 10 is constituted by a headed bolt 32 screwed into a tapped aperture 9A the bolt head being housed within an enlarged aperture 9B, while on the bolt shank the rotary cutter 11 is journalled. Finally, in Figure 24, the spindle 10 is constituted by a pin 35, on which is journalled the rotary cutter 11, the pin 35 having two spaced apart tangential grooves 39 each to receive an end of a grub screw 45 each located in one of a pair of parallel tapped holes 46 in each cheek 8. Again, the grooves 39 could be circumferential.

With regard to the releasable retention of a shank 3 in an aperture 18 three possibilities are illustrated respectively in Figures 1, 3, and 4. In Figure 1, the shank 3 is provided with a pair of grooves 47 in opposite shank faces 48. A pair of similar grooves 49 are provided in opposite faces 50 of the aperture 18. When the cutting tool 1 has been inserted in the mounting box 19, with seating surfaces 5 engaging corresponding surfaces on the mounting box 19 and thereby determining the extent of penetration of the shank 3 into its aperture 18, the grooves 47 and 49 are located opposite one another so that two retaining pins 51 may be inserted. Alternatively, the pins 51 may be constituted by the limbs of a "U"-shaped staple. In Figure 3, the shank 3 is provided with a recess 52, engaged by a withdrawable pin 53 with a head 54 engageable by an extraction tool, tbe pin 53 being bonded externally to a rubber bush 55 in turn bonded externally to a screw element 56 screwed into a tapped hole 57 in the tool head 4. In Figure 4 the shank 3 is provided with an annular groove which permanently retains a deformable ring 58, e.g. of Neoprene (Trade Mark) the ring engaging an interfering recess 59 provided in the tool head 4.

CLAIMS

1. A cutting tool for mounting on a rotary cutting head comprising a shank for insertion in an aperture of the rotary cutting head, an enlarged head at one end of the shank providing at least one seating surface for the cutting tool, the shank being provided with a formation or element by which it may be releasably retained within the aperture, a slot provided in a side of the tool head remote from the shank, a spindle secured across the slot and a roller cutter mounted on the spindle and rotatable with respect to the tool head, a portion of the roller cutter being located within the slot and another portion of the roller cutter projecting from the tool head in a direction away from the shank.

2. A cutting tool as claimed in Claim 1 of generally elongate form.

3. A cutting tool as claimed in Claim 1 of cranked form.

4. A cutting tool as claimed in any preceding Claim, wherein rotation of the roller cutting with respect to the tool head is effected by rotatably mounting the roller cutter on the spindle.

5. A cutting tool as claimed in any one of Claims 1 to 3, wherein rotation of the roller cutter with respect to the tool head is effected by having the roller cutter fixed to the spindle with the latter rotatably mounted in the tool head.

6. A cutting tool as claimed in any one of Claims 1 to 3, wherein rotation of the roller cutter with respect to the tool head is effected by having the roller cutter rotatably mounted on the spindle and the spindle rotatably mounted in the tool head.

7. A cutting tool as claimed in any preceding Claim, wherein rotation between the rotary cutter and the spindle and/or spindle and tool head is accommodated by journal bearings.

8. A cutting tool as claimed in any one of Claims 1 to 6 wherein rotation between the rotary cutter and spindle and/or spindle and tool head is accommodated by roller bearing.

9. A cutting tool as claimed in any one of Claims 1 to 6 wherein rotation between the rotary cutter and spindle and/or spindle and tool head is accommodated by ball bearings.

10. A cutting tool as claimed in Claim 8 or Claim 9 wherein the bearings are of the pre-sealed kind.

11. A cutting tool as claimed in any one of Claims 7, 8 or 9, wherein the bearings are provided with a grease hole or nipple.

12. A cutting tool as claimed in any preceding Claim, wherein the spindle is readily removable from the tool head.

13. A cutting tool as claimed in any preceding Claim, wherein the axis of rotation of the spindle lies on the central longitudinal axis of the shank.

14. A cutting tool as claimed in any one of Claims 1 to 12 wherein the axis of rotation of the spindle lies in advance of the central longitudinal axis of the shank.

15. A cutting tool as claimed in any one of Claims 1 to 12, wherein the axis of rotation of the spindle lies behind the central longitudinal axis of the shank.

16. A cutting tool as claimed in any preceding Claim, wherein the spindle is located at right angles to the plane of the slot.

17. A cutting tool as claimed in any one of Claims 1 to 15, wherein the spindle is located at $<45°$ to the plane of the slot.

18. A cutting tool as claimed in any preceding Claim, wherein the shank is of circular cross-section.

19. A cutting tool as claimed in any one of Claims 1 to 17, wherein the shank is of non-circular cross-

section.

20. A cutting tool as claimed in any preceding Claim, wherein the spindle is secured to the tool head by welding.

21. A cutting tool as claimed in any one of Claims 1 to 19, wherein the spindle is secured to the tool head by circlips.

22. A cutting tool as claimed in any one of Claims 1 to 19, wherein the spindle is secured to the tool head by a threaded part of the spindle engaging a nut or a tapped hole in the tool head.

23. A cutting tool as claimed in any one of Claims 1 to 19, wherein the spindle is secured to the tool head by grub screws.

24. A cutting tool as claimed in any one of Claims 1 to 19, wherein the spindle is secured to the tool head by two pins engaging grooves in the spindle, one to each side of the slot.

25. A cutting tool as claimed in any preceding Claim, wherein the roller cutter is constituted by one or more disc-like cutters.

26. A cutting tool as claimed in any preceding Claim, wherein the roller cutter is formed with a plurality of cutting edges.

27. A cutting tool as claimed in Claim 26, wherein the cutting edges are sharp.

28. A cutting tool as claimed in Claim 26, wherein the cutting edges are flat.

29. A cutting tool as claimed in Claim 26, wherein the cutting edges are round.

30. A cutting tool as claimed in Claim 26, wherein the cutting edges are formed of a material of greater hardness than the remainder of the roller cutter.

31. A cutting tool as claimed in any one of Claims 25 to 30, wherein the cutters are provided with hard metal inserts.

32. A cutting tool as claimed in Claim 31, wherein the inserts are of tungsten carbide.

33. A cutting tool as claimed in any one of Claims 25 to 30, wherein the cutters are provided with hard metal facings.

34. A cutting tool as claimed in Claim 33, wherein the facings are deposited by spraying or welding.

35. A cutting tool as claimed in any one of Claims 25 to 34, wherein the cutters are provided with indentations or reliefs.

36. A cutting tool as claimed in any one of Claims 25 to 35, wherein the one or more cutters provide a plurality of cutting edges all of one diameter and thickness.

37. A cutting tool as claimed in any one of Claims 25 to 35, wherein the one or more cutters provide a plurality of cutting edges which vary in diameter and/or thickness.

38. A cutting tool as claimed in any preceding Claim, wherein the tool head is fixed with respect to the shank.

39. A cutting tool as claimed in any one of Claims 1 to 38, wherein the tool head is rotatable with respect to the shank.

40. A cutting tool as claimed in any preceding Claim, wherein the one or more seating surfaces of the tool head are constituted by flat surfaces.

41. A cutting tool as claimed in any one of Claims 25 to 40, wherein the cutter(s) is a casting from high chromium and/or manganese steel.

42. A rotary cutting head for a mineral cutting machine provided with a plurality of tools as defined in any preceding Claim.

43. A rotary cutting head as claimed in Claim 40, having an aperture provided in a mounting box for each cutting tool, the aperture being of a cross-section to match the shank of a cutting tool to be inserted in the aperture.

44. A rotary cutting head as claimed in Claim 43, wherein the mounting boxes are secured by welding to the rotary cutting head.

45. A rotary cutting head as claimed in any one of Claims 42 to 44, wherein each mounting box is provided with seating surface(s) to receive corresponding seating surfaces(s) of a cutting tool.

46. A rotary cutting head as claimed in any one of Claims 42 to 45, wherein the aperture is constituted by a through bore.

47. A rotary cutting head as claimed in any one of Claims 42 to 45, wherein the aperture is constituted by a blind socket.

48. A rotary cutting head as claimed in any one of Claims 42 to 47, wherein each mounting box is provided with a flat surface for locating against a corresponding flat shoulder of the tool.

49. A cutting tool for mounting on a rotary cutting head substantially as hereinbefore described with reference to Figures 1, 2, 5A and 5B of the accompanying drawings.

50. A cutting tool for mounting on a rotary cutting head substantially as hereinbefoe described with reference to Figure 3 of the accompanying drawings.

51. A cutting tool for mounting on a rotary cutting head substantially as hereinbefore described with reference to Figure 4 of the accompanying drawings.

52. A cutting tool for mounting on a rotary cutting head comprising a roller cutter substantially as hereinbefore decribed with reference to Figures 6A and 6B of the accompanying drawings.

53. A cutting tool for mounting on a rotary cutting head comprising a roller cutter substantially as hereinbefore described with reference to Figures 7A and 7B of the accompanying drawings.

54. A cutting tool for mounting on a rotary cutting head comprising a roller cutter substantially as hereinbefore described with reference to Figures 8A and 8B of the accompanying drawings.

55. A cutting tool for mounting on a rotary cutting head comprising a roller cutter substantially as hereinbefore described with reference to Figures 9A and 9B of the accompanying drawings.

56. A cutting tool for mounting on a rotary cutting head comprising a roller cutter substantially as hereinbefore described with reference to Figures 10A and 10B of the accompanying drawings.

57. A cutting tool for mounting on a rotary cutting head comprising a roller cutter substantially as hereinbefore described with reference to Figures 11A and 11B of the accompanying drawings.

58. A cutting tool for mounting on a rotary cutting head comprising a roller cutter substantially as hereinbefore described with reference to Figures

12A and 12B of the accompanying drawings.

59. A cutting tool for mounting on a rotary cutting head comprising a roller cutter substantially as hereinbefore described with reference to Figure 13 of the accompanying drawings.

60. A cutting tool for mounting on a rotary cutting head comprising a roller cutter substantially as hereinbefore described with reference to Figure 14 of the accompanying drawings.

61. A cutting tool for mounting on a rotary cutting head comprising a roller cutter substantially as hereinbefore described with reference to Figure 15 of the accompanying drawings.

62. A cutting tool for mounting on a rotary cutting head comprising a roller cutter substantially as hereinbefore described with reference to Figure 16 of the accompanying drawings.

63. A cutting tool for mounting on a rotary cutting head comprising a roller cutter substantially as hereinbefore described with reference to Figure 17 of the accompanying drawings.

64. A cutting tool for mounting on a rotary cutting head comprising a roller cutter substantially as hereinbefore described with reference to Figure 18 of the accompanying drawings.

65. A cutting tool for mounting on a rotary cutting head substantially as hereinbefore described with reference to Figure 19 of the accompanying drawings.

66. A cutting tool for mounting on a rotary cutting head substantially as hereinbefore described with reference to Figure 20 of the accompanying drawings.

67. A cutting tool for mounting on a rotary cutting head substantially as hereinbefore described with reference to Figure 21 of the accompanying drawings.

68. A cutting tool for mounting on a rotary cutting head substantially as hereinbefore described with reference to Figure 22 of the accompanying drawings.

69. A cutting tool for mounting on a rotary cutting head substantially as hereinbefore described with reference to Figure 23 of the accompanying drawings.

70. A cutting tool for mounting on a rotary cutting head substantially as hereinbefore described with reference to Figure 24 of the accompanying drawings.

Printed for Her Majesty's Stationery Office by Croydon Printing Company Limited, Croydon Surrey, 1980.
Published by the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.